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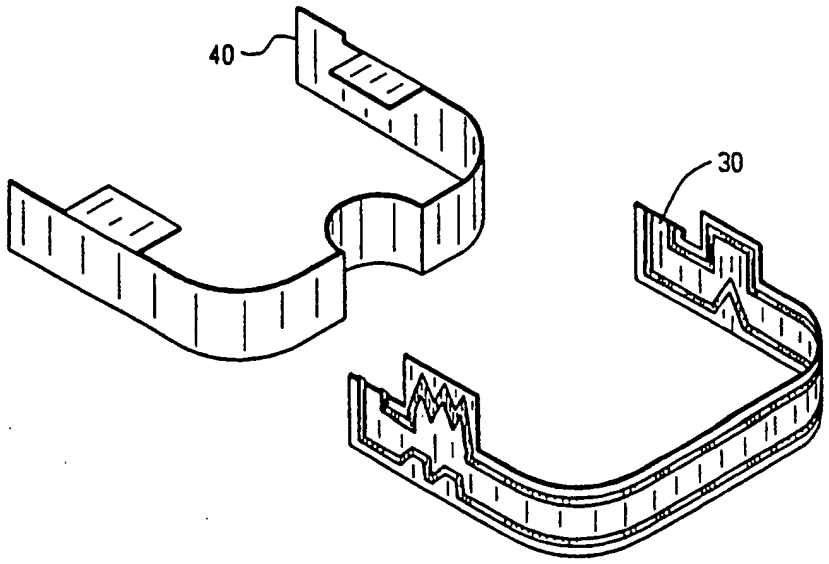
(54) Title: DUAL EMBEDDED ANTENNA FOR AN RF DATA COMMUNICATIONS DEVICE



(57) Abstract

An RF antenna system is disclosed having at least one meandering antenna line with an aggregate structure formed to substantially extend in two dimensions, to effectively form a dipole antenna. The meandering antenna line includes at least one localized bend for providing a compressed effective antenna length in a compact package. The present antenna can be made as an antenna system having discrete transmit and receive antenna lines, so as to form a dual antenna system. The localized bends on each line electromagnetically couple with the respective bends on the other line, thus increasing electromagnetic coupling efficiency, thereby increasing antenna bandwidth and gain.

DUAL EMBEDDED ANTENNA FOR AN RF DATA COMMUNICATIONS DEVICE

Background of the Invention

The present invention is directed to the field of antennas used for RF data communications devices, particularly those used to transmit and receive digital signals, e.g., two-way pagers and the like. The antennas used with previous RF data communications devices are prone to significant problems. Many previous pagers are "one-way" pagers that are only able to receive a pager signal. However, many factors can contribute to the loss of an incoming message signal. Thus, it is desirable to employ a "two-way" pager that sends an acknowledgment signal to the remote station to confirm receipt of a message or to originate a message.

In previous VHF one-way pagers, it had been common to use a loop-type antenna, which is effective at receiving signals in the presence of the human body, which has properties that tend to enhance VHF radio signals. However, loop-type antennas are poor at the UHF frequencies needed for two-way pagers. Also, such antennas are typically embedded in a dielectric plastic pager body, which reduces the effective bandwidth of the received signal. Such a configuration has a very narrow bandwidth of typically about 1%. Such antennas also have poor gain performance when transmitting a signal, and are thus not useful for a two-way pager design.

Many previous two-way telecommunications devices use a "patch" antenna, in which a large, flat conducting member is used for sending and receiving signals. Patch antennas permit two-way communication under certain

maintenance of the unit. Also, this switch is lossy, reducing antenna gain by about 0.5 dB. Further, with this design, LCD placement with respect to the antenna is critical, requiring fine tuning and tight manufacturing tolerances, resulting in labor-intensive (and thus expensive) manufacturing. Also, with the previous antenna design, impedance matching with the radio circuit is difficult. Testing the previous antenna is difficult since it could only be tested in an assembled pager, and so antenna failures contribute to unit failures during testing. Also, the antenna tends to interfere with the radio components in the pager, thereby further reducing performance.

Brief Description of the Invention

In view of the drawbacks and disadvantages associated with previous systems, there is a need for an RF communications antenna system that enables reliable two-way communication.

There is also a need for a two-way RF communications antenna system that provides a uniform radiation pattern within 360 degrees of azimuth.

There is also a need for an RF antenna system that is insensitive to variations in environmental conditions.

There is also a need for an RF antenna system that is simple in construction and can be manufactured with relaxed tolerances.

There is also a need for an RF antenna system that can be easily tested.

These needs and others are satisfied by the present invention in which a RF antenna system is provided having at least one meandering antenna line with an aggregate structure formed to substantially extend in two dimensions, to effectively form a half-wave, top-loaded monopole antenna. The meandering antenna line includes at least one localized bend for providing a compressed effective physical antenna length in a compact package. The present antenna

As an additional feature, the present meandering antenna line 12 can include one or more extended portions 14, each having one or more localized bends 16. These localized bends 16 provide further compression of the antenna length. For example, a 16 cm antenna (corresponding to the half-wavelength of approximately a 900 MHz signal) can be preferably compressed in a 8.5 x 6 cm pager body in the manner illustrated in Fig. 1. In principle, even greater lengths can be compressed into smaller bodies by increasing the number of bends 16, providing greatly improved efficiency. The present design provides excellent radiation pattern characteristics, providing an omnidirectional "doughnut" radiation pattern that propagates in 360 degrees of azimuth.

The present antenna system 10 can include a single meandering antenna line 12, but in the preferred embodiment, the present antenna system 10 can include plural distinct meandering lines. In the preferred embodiment, as illustrated in Fig. 1, the present antenna system includes two meandering antenna lines 12, 22, where one of the lines 12, 22 is a transmit (Tx) antenna and the respective other line 12, 22 is a receiving (Rx) antenna. In the embodiment shown, the line 12 is preferably the Tx line and the line 22 is preferably the Rx line. The Tx line is preferably positioned to provide an advantageous transmission pattern with respect to the geometry of the internal pager components, so as to insure transmission to the remote station. This permits two separate narrowband channels to be used for Rx and Tx signals, rather than one wideband channel, as with the previous single antenna designs. By providing two center frequencies, the bandwidth extremities are reduced. Also, each antenna line 12, 22 can interface directly with the radio circuits, thereby eliminating the send/receive RF switch used with previous single antennas. In this way, the present antenna reduced complexity and cost by

900 MHz	6 dB
901 MHz	6 dB
902 MHz	5 dB

Each antenna line 12, 22 has an associated eigenvector, and without coupling, these eigenvectors overlap along a common bandwidth. The coupling effect between the adjacent bends 16, 26 causes a separation of eigenvectors, in which the eigenvectors split asymmetrically about a central frequency, resulting in an increased effective bandwidth for the dual antenna system. Through the coupling effect, each meandering antenna line 12, 22 has the effective bandwidth of the coupled system. This coupling is accomplished without the LCD anisotropic media used in the U.S. Serial No. 08/715,347, and so the present invention provides excellent results without being sensitive to the proximity problems of the previous device.

As best seen in Fig. 2, the meandering lines 12, 22 of the present dual antenna system are formed on a flexible substrate, e.g., a plastic dielectric retainer. The retainer 40 is formed of a plastic dielectric material which can be easily shaped to create the desired configuration. Also, the meandering lines 12, 22 can easily be formed directly on the flexboard 30 by etching a desired pattern directly onto a copper layer on the flexible circuit board material. In the way, any desired line pattern can be created simply and economically, permitting precise control of current densities along the antenna assembly.

Additionally, the retainer 40 assists in coupling between the lines due to the dielectric properties of the plastic material. The retainer 40 also creates a partial barrier between the antenna system and the pager circuit board, as the dielectric material is somewhat dispersive of the electromagnetic wave, moving the energy out of the bandwidth of the radio, and reducing interference.

bandwidth antennas. Further, the tolerances of components in the pager system used with the present invention are reduced, and construction is simplified.

As described hereinabove, the present invention solves many problems associated with previous systems, and presents many improvements in efficiency and operability. However, it will be appreciated that various changes in the details, materials and arrangements of parts which have been herein described and illustrated in order to explain the nature of the invention may be made by those skilled in the art within the principle and scope of the invention as expressed by the appended claims.

7. A dual antenna system for an RF data communications device comprising:

a receive antenna comprising a first meandering antenna line having an aggregate structure formed so as to substantially extend in two dimensions, so as to effectively form a dipole antenna, wherein the first meandering antenna line includes at least one localized bend; and

a transmit antenna comprising a second meandering antenna line having an aggregate structure formed so as to substantially extend in two dimensions, so as to effectively form a top-loaded monopole antenna, wherein the second meandering antenna line also includes at least one localized bend.

8. The dual antenna system of claim 7, wherein the respective at least one localized bend on each line increases electromagnetic coupling efficiency with the respective other line.

9. The dual antenna system of claim 7 wherein each respective antenna line is tuned for a separate bandwidth.

10. The dual antenna system of claim 7 wherein the meandering antenna lines are formed onto a flexible substrate and affixed to a rigid dielectric retainer.

11. The dual antenna system of claim 7 wherein at least one of said antenna lines further comprise at least one high current portion for reducing interference from close proximity metal components.

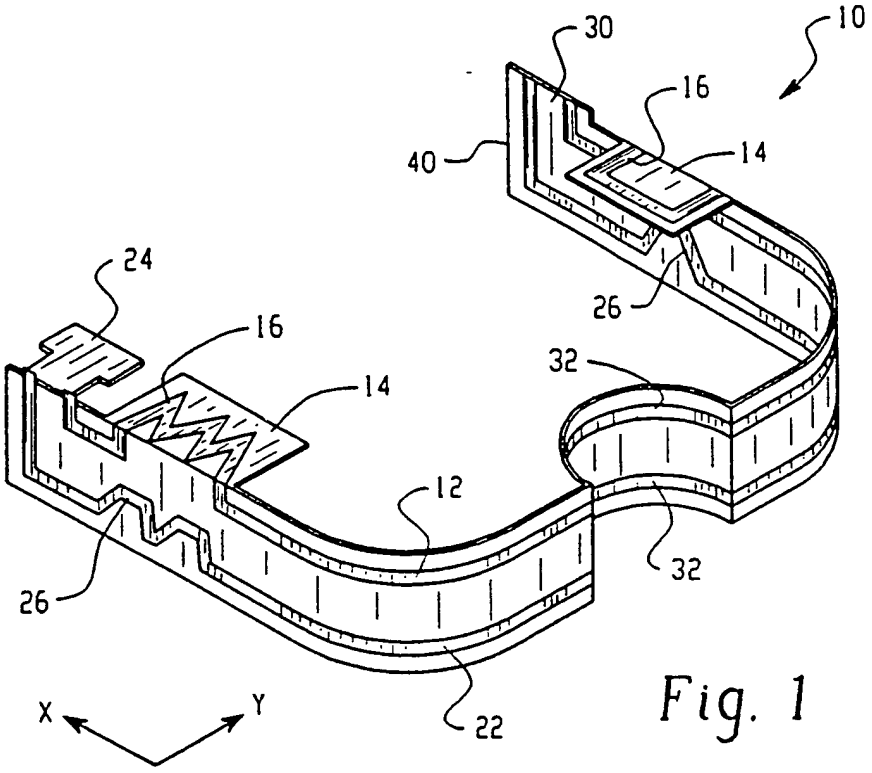


Fig. 1

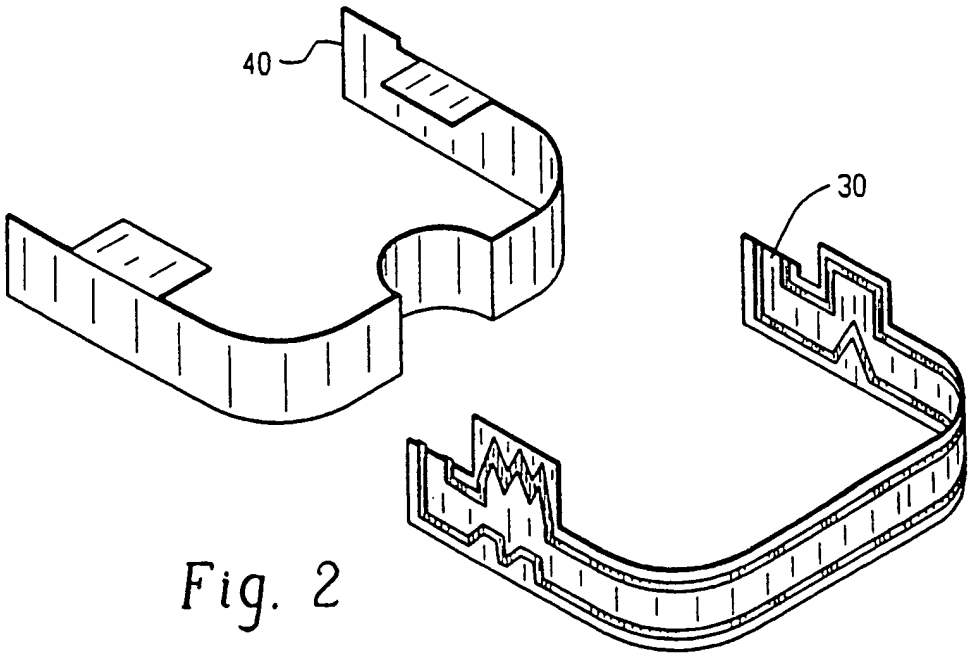


Fig. 2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 99/00602

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01Q1/24 H01Q1/38 H01Q1/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	---	2,10
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[X] Further documents are listed in the continuation of box C

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 October 1999	21/10/1999

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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